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UPGRADING OF THE BOROWIEC LASER STATION

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Abstract

The major upgrade at Borowiec SLR since the last Workshop is the new third generation laser, which has been installed in September 1991. Short description of the new CONTINUUM laser and first results of satellites observations are presented. The results confirm expected increase in accuracy (3-5 cm) and in the number of measurements per satellite pass (several hundred).

In addition, information about second Borowiec SLR system is presented. Borowiec No 2 is designated for Tunisia in the next year. System is not yet operational.

1. Introduction.

The Borowiec SLR System is operating since 1988 (Schillak, 1991). During this time the system has provided observations to satellites LAGEOS, Ajisai, Starlette, GEO-IK-1 and ERS-1. The system has only night-time tracking capability. The single shot precision was estimated to be about ± 20 cm. Our activity were strongly limited by bad weather conditions and technical problems (Fig.1).

Since the last workshop several upgrading in the system has been done;

- 1990, February, transmitter telescope has been added and divergence of laser beam changed 8X,
- 1990, October, generation of normal points onsite,
- 1990, October, replacement of the photomultiplier FEU-87 by the RCA 8852,
- 1991, June, a received energy detector has been introduced,
- 1991, September, new third generation laser has been installed,
- 1991, October, new real-time software has been introduced,
- 1992, January, microcomputer PC/AT has been used for pre- and post-observation programs, real-time graphic program on PC/AT has been added.

The main upgrading of the system was installation of the new laser.

2. Laser CONTINUUM.

The Nd:YAG laser type CONTINUUM PY-62-10 has been employed in September, 1991. The scheme of the laser transmitter is shown in Fig.2. The laser is a cavity dumped active/passive mode-locked system. The cavity dump consist of the electro-optic Pockels cell triggered by a photodiode. The selected output single pulse is ejected via polarizer when the predetermined intensity level is reached. The oscillator delivering about 3-5 mJ at 1064 nm. The oscillator and preamplifier are pumped by the same flashlamp. A telescope for beam expansion is placed before main amplifier. The amplifier has four flashlamps. A type II KD^*P crystal is used for doubling.

The laser can be operated in two different modes;

- with ETALON (100 ps, 110 mJ at 532 nm),
- without ETALON (35 ps, 65 mJ at 532 nm).

The pulse repetition rate can be varied from 1 to 10 Hz (10 Hz is optimum). Pulse stability - 7%, diameter of output laser beam - 12 mm, divergence - 0.4 mrad, jitter of ext. trig. ± 10 us.

3. Results.

The last pass with old 4 ns laser was performed on August 18, 1991, first pass with new CONTINUUM laser on September 28, 1991. The results of SLR using new laser are shown in Table 1. The table shows results of two periods of activity; I - October, November, II - December, January. First period was dedicated to the introducing of new real-time software , second one to achieve maximum efficiency in actual station configuration. The last results show that single shot RMS is equal to 3-5 cm and further increasing of accuracy is limited by classic photomultiplier RCA 8852 (jitter is about 1 ns). Maximum number of returns per one pass was about 1500 for LAGEOS and more than 3000 for Ajisai. The Fig.3 and 4 shows the advantages of new laser in comparison to the old one. To further improve the single shot RMS the photomultiplier needs to be changed to a micro-channel plate or an Avalanche photodiode.

Table 1. Results of the observations performed with CONTINUUM laser from September 28, 1991 to January 31, 1992.

SATELLITE	PERIOD	PASSES	RETURNS	RETURNS/ ONE PASS	RMS cm
LAGEOS	Oct-Nov	8	416	52	7.0
AJISAI		12	5313	443	4.8
LAGEOS	Dec-Jan	8	3516	440	5.0
AJISAI		13	17268	1328	4.0

Problems;

- delay of the mount as result of the short steps (100 ms), step by step mode of the mount should be changed to continuous mode, problem is especially hard for low satellites as ERS-1,
- small operational memory of old computer limits our possibility to maximum 2500 returns per pass, also breaks of about 1 min appeared due to 5 min bursts, microcomputer PC/AT must be attached for real-time operations.

4. Status and parameters of Borowiec-2 SLR system.

The second SLR system has been installed in Borowiec Observatory in 1990. The system is destined to place in Tunisia. The parameters of actual configuration are presented in Table 2.

Table 2. The actual parameters (1992) of Borowiec-2 SLR system.

Laser - Nd:YAG
- pulse energy - 250 mJ (green)
- pulse width - 4 ns
- repetition rate - 1 Hz

Mount - Az-El computer controlled
- tracking - continuous
- tracking possibility - low satellites, Lageos, Etalons
- encoder resolution - 1.8 arcsec
- laser in Coude

Transmitting optics
- diameter - 20 cm
- gain - 8x
- output divergence - 10 arcsec

Receiver - Cassegrain
- diameter - 65 cm
- diameter of secondary mirror - 20 cm
- field of view - 5 arcmin

Guide telescope - Maksutov
- diameter - 20 cm
- field of view - 1°

Photomultiplier - RCA 8852

Time Interval Counter - PS-500, 60 ps accuracy

Discriminator - Tennelec 454, or B-6

Time Base - GPS Time Receiver

accuracy - 100 ns

Computer - PC/AT

Software - Real Time tracking programs, IRVINT and ORBMESS

predictions, initial analysis programs, star programs

language - C

Calibration - Pre and Post, external

Expected overall accuracy of the system - $\pm$15 cm

Operating staff - 2 persons

The current 4 ns laser should be exchanged for the better third generation system in the near future. System is not yet operational. The first target calibration is expected this year and system will be operational at Borowiec in 1993.

5. Localization in Tunisia.

Installation of the SLR station in Tunisia is realized in cooperation between Office de la Topographie et de la Cartographie, Tunisie and Space Research Center of Polish Academy of Sciences. Station will be placed in new geodynamical center 10 km north from town Medenine in south part of Tunisia. The Borowiec-2 SLR system will be operational in Tunisia probably in 1994.

Acknowledgments.

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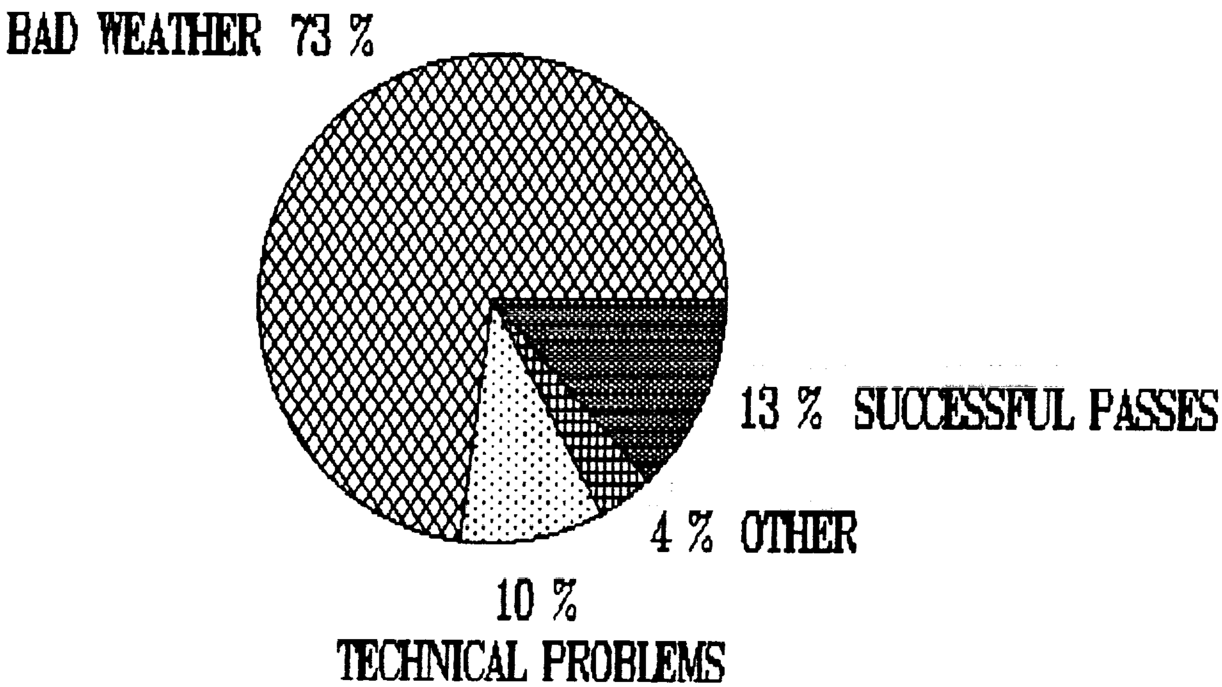
References.

Schillak S., 1991, Borowiec Laser Station 1986-1990. Artificial Satellites, Planetary Geodesy, No. 15, Vol. 26, No. 1, Warsaw, Poland, pp. 13-18.

Fig. 1 OPERATING PERIODS IN 1990
(284 DAYS)



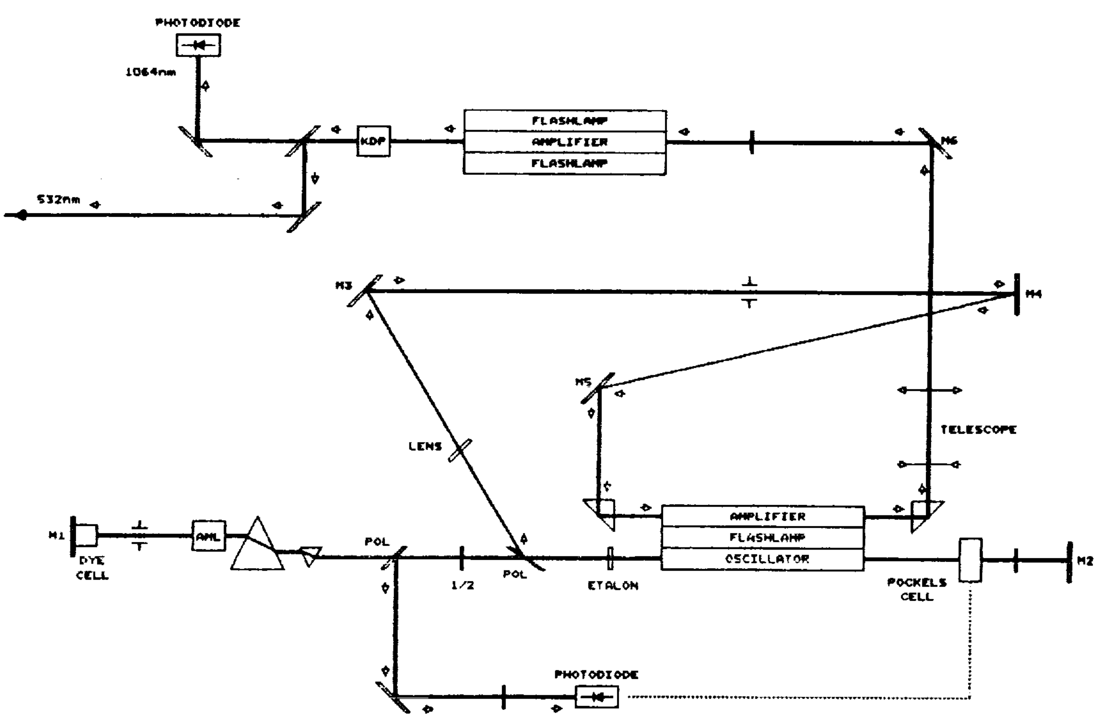


Fig.2 LASER Nd:YAG CONTINUUM PY-62

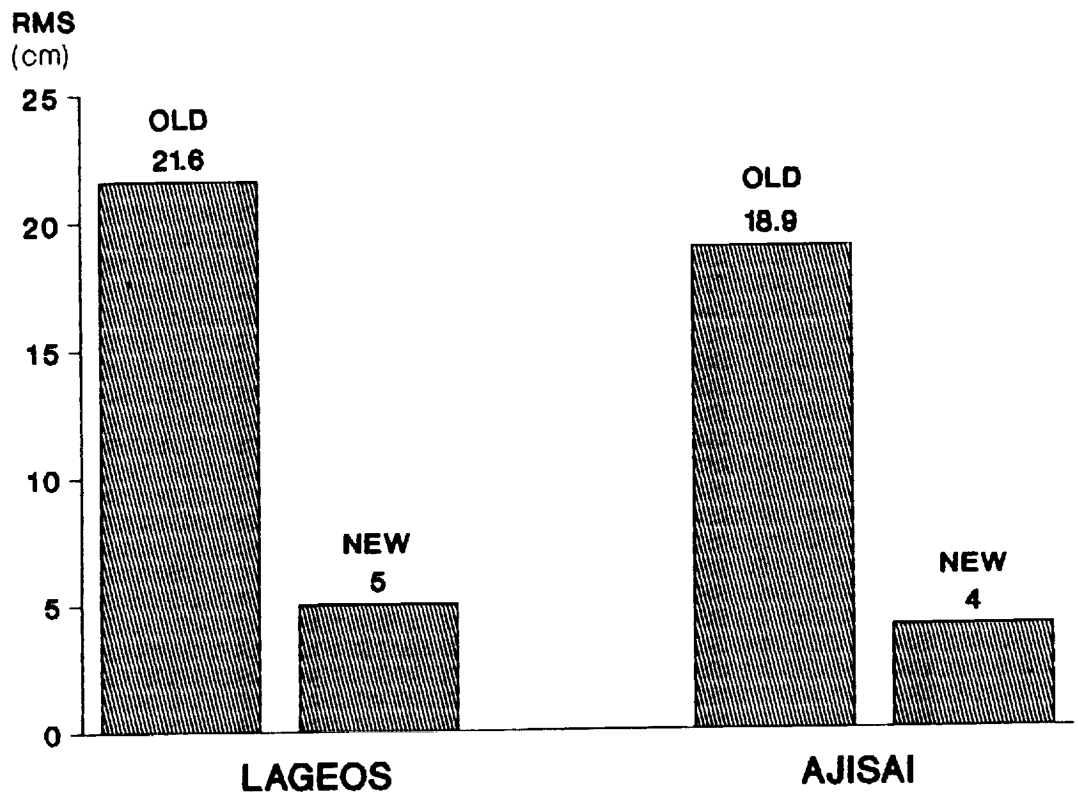


Fig.3 Single shot RMS - old and new laser.

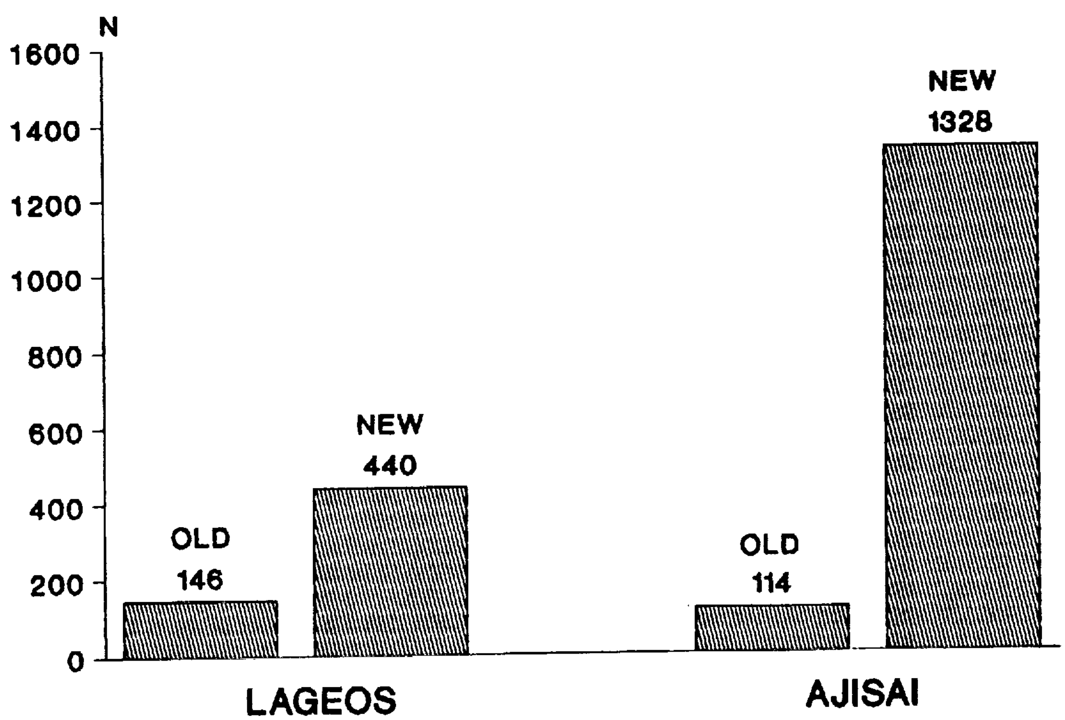


Fig.4 Returns per one pass - old and new laser